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DEPARTMENT OF COMMERCE AND INDUSTRIES

FISHERIES AND MARINE BIOLOGICAL SURVEY DIVISION

INVESTIGATIONAL REPORTS Nos. 9 AND 10

# No. 9: A PRELIMINARY REPORT

on the

# VITAMIN A CONTENT OF THE LIVER OIL OF THE STOCK FISH

*(Merluccius capensis)*

and the

# CAPE SPINY DOGFISH

*(Squalus acutipinnis)*

and

# No. 10: NOTES ON THE VITAMIN A CONTENT OF THE LIVER OIL

of the

# VAALHAAI OR SOUPFIN SHARK

*(Galeorhinus zyopterus)*

BY

J. A. M. ARCHER, M.Sc., Professional Officer.

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DEPARTMENT OF COMMERCE AND INDUSTRIES.

## FISHERIES AND MARINE BIOLOGICAL SURVEY DIVISION.

# INVESTIGATIONAL REPORT
## No. 9.

### A PRELIMINARY REPORT
### ON
### THE VITAMIN A CONTENT OF THE LIVER OIL
### of the
### STOCKFISH (*MERLUCCIUS CAPENSIS*)
### and the
### CAPE SPINY DOGFISH (*SQUALUS ACUTIPINNIS*)
### from the
### WEST COAST
### Approximately between Latitudes 33° S. and 29° S.

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Professional Officer.

*Reprint from "Commerce & Industry", December, 1948.*

# A PRELIMINARY REPORT

# ON

# THE VITAMIN A CONTENT OF THE LIVER OIL OF *(a)* THE STOCKFISH (*MERLUCCIUS CAPENSIS*) AND *(b)* THE CAPE SPINY DOGFISH (*SQUALUS ACUTIPINNIS*) FROM THE WEST COAST APPROXIMATELY BETWEEN LATITUDES 33° S. AND 29° S.

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## Explanatory.

An attempt was made to ascertain whether the oil- and vitamin A-content of stockfish and dogfish livers from the more northerly grounds differ from those from the more southerly grounds. It was impossible, however, to obtain the necessary samples from the whole area at the same time owing to the fact that only one survey vessel was available. The research work was thus spread out over a period of five months, viz., from the beginning of May to the beginning of October, 1947. At the beginning of this work no reproductive activity either in the stockfish or the dogfish was seen, but the most northerly and the most southerly stations were worked during the start of the breeding season of the stockfish, and female dogfish containing embryos were also encountered. This means that changes took place in the reproductive cycle, which, owing to the fact that it may influence the oil- and vitamin A-content, might affect the final results.

All the fish used in this work were caught in the otter trawl.

The whole region between latitude 33° S. and latitude 29° S. was divided into eight different areas which were not sharply demarcated. In each area various stations were worked and at each station the net was trawled for about two miles.

### *(a)* Stockfish.

From each station the livers of all stockfish of 55 cm. in length or larger were retained, and the livers of the males and the females were kept separate. The livers from all stations of one area were mixed (those of the males and females being kept separate) and preserved with borax. At the end of the trip the two kinds of livers were worked separately. The weights of the various groups of livers varied from 100 to 350 lb. each. The quantity of livers from male stockfish was approximately 50 per cent. less than the quantity from females.

#### Method of Treatment.

Each group of livers was minced and mixed with twice its weight of water. Two per cent. commercial caustic soda by (weight of liver) was added and the mass cooked with live steam until well disintegrated. The warm mixture was then separated by means of a

TABLE I.—STOCKFISH AND DOGFISH LIVER OIL.

| Latitude. | 33° 35′ S.<br>32° 41′ S. | 33° 12′ S.<br>32° 43′ S. | 32° 44′ S.<br>32° 23′ S. | 32° 09′ S.<br>31° 39′ S. | 31° 38′ S.<br>31° 01′ S. | 31° 18′ S.<br>30° 44′ S. | 31° 01′ S.<br>29° 18′ S. | 30° 49′ S<br>29° 15′ S. |
|---|---|---|---|---|---|---|---|---|
| Average depth (fathoms)..... | 143 | 120 | 177 | 154 | 153 | 150 | 172 | 143 |
| Average surface temp. (° C.)... | 14·9 | 14·9 | 15·5 | 15·8 | 14·0 | 13·0 | 14·6 | 14·0 |
| Stations..... | 3 | 5 | 13 | 10 | 4 | 7 | 12 | 9 |
| Date..... | 3–8 October, 1947. | 23–28 Sept., 1947. | 5–15 May, 1947. | 20–29 May, 1947. | 5–11 June, 1947. | 18–27 June, 1947. | 26–29 August, 1947. | 14–23 August, 1947. |
| **STOCKFISH.** | | | | | | | | |
| Percentage males..... | 34 | 30 | — | 20 | — | — | 36 | 48 |
| Percentage over 75 cm..... | 21·6 | 29·4 | 37·4 | 29·4 | 13·1 | 5·8 | 10 | 3·5 |
| Percentage oil in liver— | | | | | | | | |
| Males..... | — | — | 36·5 | 47 | 25·8 | 33 | 20·8 | 46·4 |
| Females..... | 30·8 | — | 32·1 | 44·5 | 29·4 | 36 | 35·4 | 33·2 |
| E. 1 per cent. 1 cm. 0·328 mu. | | | | | | | | |
| Males..... | — | — | 3·08 | 2·74 | 1·87 | 2·44 | 2·3 | 2·5 |
| Females..... | 9·91 | — | 5·1 | 4·74 | 4·25 | 3·08 | 3·4 | 3·88 |
| M.I.U. Vit. A per lb. liver— | | | | | | | | |
| Males..... | — | — | 0·817 | 0·935 | 0·351 | 0·585 | 0·348 | 0·843 |
| Females..... | 2·217 | — | 1·190 | 1·532 | 0·908 | 0·805 | 0·872 | 0·936 |
| **DOGFISH.** | | | | | | | | |
| Percentage males..... | 36 | 51 | 52 | — | — | 50 | 36 | 80 |
| Percentage oil in liver— | | | | | | | | |
| Males..... | 56·2 | 51·4 | 47·3 | 50·7 | 53·4 | 50 | 57·7 | 62·8 |
| Females..... | 49·6 | 54·6 | 35·3 | 31·6 | 63·6 | 44 | 52·6 | — |
| E. 1 per cent. 1 cm. 0·328 mu. | | | | | | | | |
| Males..... | 8·3 | 7·6 | 5·5 | 5·30 | 5·18 | 5·56 | 3·2 | 6·61 |
| Females..... | 3·95 | 3·9 | 3·95 | 3·64 | 3·18 | 3·72 | 2·16 | 2·86 |
| M.I.U. Vit. A per lb. liver— | | | | | | | | |
| Males..... | 3·397 | 2·838 | 1·90 | 1·952 | 2·013 | 2·019 | 1·341 | 3·0 |
| Females..... | 1·423 | 1·547 | 1·013 | 0·836 | 1·470 | 1·189 | 0·825 | — |

Sharples centrifuge. After the whole mass had passed through the centrifuge, clean water was run into the centrifuge to recover as much oil as possible The small quantity of oil which may have remained in the centrifuge was measured as carefully as possible.

TABLE II.—STOCKFISH LIVER OIL.

| Sexual Condition. | Total Length, cm. | Weight of Fish, gm. | Weight of Liver, gm. | Percentage Oil in Liver. | $E\ \frac{1\%}{1\ cm.}$ ·328 mu. | I.U. Vitamin A per Fish. |
|---|---|---|---|---|---|---|
| **Males.** | | | | | | |
| Gonads very small. | 40·5 | 566 | 17·8 | 51·7 | 0·55 | 8,100 |
| Gonads very small. | 41·5 | 454 | 9 | 18·5 | — | — |
| Gonads very small. | 42·8 | 340 | 10 | 6·5 | — | — |
| Gonads small..... | 44 | 793 | 25·5 | 40 | 0·82 | 13,500 |
| Gonads small..... | 49 | 736 | 26 | 25 | 1·10 | 11,500 |
| Gonads small..... | 51·7 | 962 | 22·5 | 20·6 | 0·87 | 6,500 |
| Gonads small..... | 53·5 | 1,133 | 49·3 | 47 | 1·4 | 52,000 |
| Gonads small..... | 54·5 | 1,020 | 43·5 | 37·1 | 1·50 | 38,700 |
| Gonads small..... | 56 | 1,133 | 30 | 37 | 1·23 | 21,800 |
| Gonads small..... | 56·1 | 1,133 | 32 | 33 | 1·30 | 22,300 |
| Gonads small..... | 71·5 | 2,380 | 102 | 51 | 2·29 | 190,600 |
| Gonads small..... | 71·5 | 1,870 | 117·5 | 36 | 0·99 | 67,000 |
| Gonads large..... | 73·5 | — | 57 | 7 | 18·58 | 118,600 |
| Gonads small..... | 73·6 | 2,777 | 91 | 46·3 | 1·59 | 107,100 |
| Gonads large..... | 75 | — | 37·2 | 6·9 | 48·78 | 200,500 |
| Gonads small..... | 79·3 | 2,947 | 97 | 48·3 | 1·26 | 94,400 |
| Gonads large..... | 84 | — | 268 | 32·2 | 11·48 | 1,585,100 |
| **Females.** | | | | | | |
| Gonads very small. | 36 | 283 | 4·3 | 31·4 | 1·63 | 3,500 |
| Gonads small..... | 59·2 | 1,133 | 55·3 | 37·6 | 0·69 | 22,900 |
| Gonads small..... | 62·2 | 1,473 | 42 | 35·7 | 1·57 | 37,600 |
| Gonads small..... | 61·5 | 2,265 | 43 | 36 | 1·71 | 42,300 |
| Gonads small..... | 62·8 | 1,586 | 35 | 30·9 | 1·05 | 18,000 |
| Gonads large..... | 62·4 | — | 78·5 | 34·2 | 1·57 | 67,400 |
| Gonads small..... | 64 | 1,586 | 12·4 | 18·3 | 1·33 | 4,800 |
| Gonads small..... | 63·5 | 1,361 | 58·8 | 43·2 | 0·96 | 39,000 |
| Spawning..... | 64·5 | — | 48·2 | 28·4 | 2·36 | 51,700 |
| Probably spent.... | 66 | 1,814 | 55·2 | 25·2 | 8·16 | 181,600 |
| Spent..... | 67 | 1,814 | 24·6 | 9·2 | 17·42 | 63,100 |
| Gonads large..... | 67·2 | 1,814 | 105 | 48·2 | 4·11 | 332,800 |
| Gonads small..... | 70·4 | 2,267 | 33·2 | 5·2 | 12·32 | 34,100 |
| Gonads small..... | 70·6 | 2,267 | 73 | 47·7 | 1·05 | 58,500 |
| Ripe..... | 74·5 | 3,684 | 106 | 33·4 | 2·99 | 169,300 |
| Gonads small..... | 76·3 | 3,684 | 139·2 | 42 | 1·71 | 160,300 |
| Spent..... | 85 | 7,254 | 252·7 | 46 | 3·91 | 727,200 |
| Ripe..... | 87 | 5,044 | 176 | 37 | 4·38 | 456,300 |
| Ripe..... | 87 | — | 152 | 25 | 8·8 | 535,000 |
| Gonads small..... | 90 | 5,270 | 269 | 33·2 | 2·11 | 301,400 |
| Spent..... | 91 | 4,251 | 109 | 28·6 | 7·26 | 362,100 |
| Ripe..... | 93 | 5,498 | 343·6 | 49·9 | 1·94 | 532,100 |
| Spent..... | 96 | 5,951 | 143 | 32·7 | 13·12 | 981,600 |
| Ripe..... | 97·6 | 6,405 | 210 | 35·9 | 8·58 | 1,035,000 |
| Ripe..... | 105 | 10,655 | 638 | 47·6 | 5·55 | 2,697,000 |
| Ripe..... | 107 | 10,940 | 627 | 47·4 | 6·4 | 3,043,000 |
| Spent..... | 120 | 12,695 | 497 | 51 | 16·19 | 6,566,000 |

Each group of livers and the oil obtained from them were carefully weighed

The vitamin A content of each mass of liver was then determined by means of the antimony-trichloride reagent with the aid of an Evelyn photo-electric colorimeter. All details are given in Table I

From each area 6 to 12 stockfish of varying lengths and both sexes were carefully weighed, and the sexual condition determined. The liver of each fish was then weighed and the oil- and vitamin A-content of each separately determined. For these determinations a definite weight of each liver was digested with 2 per cent. caustic soda and live steam and the oil was extracted with ether. Four successive extractions, each time with a quantity of ether at least twice the volume of the digested liver mass, were made for each sample. The particulars of these individual livers are given in Table II. (Those of the dog-fish in Table III).

#### Conclusions.

1. From the results (Table I) it would appear that the livers of stockfish from the more northerly areas have a lower vitamin A content per lb. of liver than those from the more southerly areas. As already stated, the changes in the reproductive cycle might have been the cause of this, because the livers of stockfish which are breeding or have recently spent, apparently contain less oil than the others, but as far as the vitamin A content is concerned, the available information does not give definite proof that this also varies in such a manner. The most northerly and the most southerly stations were, however, worked at very short intervals during a time when in both areas more or less the same percentage of breeding stockfish was encountered. Nevertheless the livers from the northern area had a lower vitamin A content per liver unit than those from the southern area. This difference is especially obvious in two groups of livers of males (0·936 M.I.U. vit. A per lb. in the north and 2·217 M.I.U. vit. A per lb in the south).

If the vitamin A content of individual livers of fish of the same sex and, as far as possible, the same size, but from different areas, is compared, it is very difficult to find any reliable difference between livers from the north and the south.

From Table II it further appears that there is an increase in vitamin A corresponding with increase in size, and this increase is especially more rapid if the stockfish reaches a length of 70 to 80 cm. The investigation further showed that in the vicinity of the mouth of the Orange River only 3·5 per cent. to 10 per cent. of the catch of 55 cm. and larger, are more than 75 cm. in length, whilst the percentage of stockfish of 75 cm. and larger, constitute 21 per cent. to 37 per cent. of the catch of 55 cm. or larger in the area Dassen Island to Saldanha Bay. This may be the reason why the average vitamin A content of stockfish livers from the northern area is lower.

2. It has already been stated that, according to available information, the livers of male and female stockfish of the same size contain more or less the same quantity of vitamin A. The quantity of international units of vitamin A per lb. of liver, as shown in Table I, is, however, higher on the average in the case of groups of livers of females. This may be an indication that over the whole area the females on the average are larger than the males.

### *(b)* Dogfish.

These livers were treated in the same way as those of the stockfish, except that *all* dogfish livers were collected.

#### Conclusions.

1. Even although there are definite variations in the vitamin A content of the livers from different areas, there is no increase or decrease in any special direction (Table I).

2. All groups of livers of male dogfish have a higher vitamin A content than the groups of female livers. Further, the individual livers of males have more vitamin A than those of females of the same size. This is very apparent in dogfish larger than 50 cm.

3. The amount of vitamin A in the liver increases with increase in size of the fish, and the rapid increase starts at a size between

55 and 65 cm. (Table III). The start of this rapid increase may be related to the sexual maturity of the dogfish.

4. The liver of a gravid female, or one that has just given birth, has in general, a lower percentage of oil than the livers of non-gravid females of the same size. Although the vitamin A content in the former cases may also be less, it certainly does not vary to the same degree.

## NOTE.

Before any definite and final conclusions can be made, many more investigations and comparative studies must be undertaken in this connection in regard to the stockfish and the dogfish.

TABLE III.—DOGFISH LIVER OIL.

| Sexual Condition. | Total Length, cm. | Weight of Fish, gm. | Weight of Liver, gm. | Percentage Oil in Liver. | $E^{1\%}_{1\text{ cm.}}$ ·328 mu. | I.U. Vitamin A per Fish. |
|---|---|---|---|---|---|---|
| **Males.** | | | | | | |
| Gonads very small. | 38 | 142 | 12·7 | 51·7 | 0·94 | 9,800 |
| Gonads small..... | 48·5 | 341 | 32 | 57·6 | 2·07 | 61,000 |
| Gonads large..... | 50·2 | 511 | 52 | 42·6 | 4·31 | 152,700 |
| Gonads fairly big.. | 51 | 540 | 52·7 | 37 | 4·36 | 136,000 |
| — | 51 | 682 | 62·6 | 60·2 | 3·59 | 216,500 |
| Gonads large..... | 51·9 | 511 | 77·4 | 62·6 | 1·51 | 117,000 |
| Gonads large..... | 55 | 908 | 69 | 59 | 3·77 | 245,500 |
| Gonads fairly small | 55 | 682 | 75 | 51 | 2·03 | 124,200 |
| Gonads large..... | 58 | 792 | 68·7 | 51·8 | 0·61 | 34,700 |
| Gonads large..... | 58·5 | 1,362 | 101 | 56·7 | 5·33 | 488,400 |
| Gonads large..... | 60 | 821 | 84·3 | 48 | 2·59 | 167,700 |
| Gonads large..... | 60·2 | — | 58·4 | 35 | 11·26 | 368,200 |
| Gonads large..... | 61·5 | 962 | 90·2 | 47·2 | 5·02 | 341,900 |
| Gonads fairly big.. | 61·5 | 906 | 105·5 | 53 | 1·27 | 113,600 |
| — | 64·5 | — | 91·4 | 38·6 | 14·61 | 824,700 |
| Gonads large..... | 67·4 | — | 129 | 54 | 11·04 | 1,230,400 |
| — | 72·2 | 1,360 | 143 | 65·5 | 4·11 | 615,900 |
| Gonads large..... | 78 | 2,039 | 179·5 | 58·6 | 1·09 | 183,400 |
| Gonads large..... | 80 | 2,380 | 241 | 57·8 | 6·98 | 1,555,700 |
| — | 81·6 | 2,720 | 319 | 59 | 6·8 | 2,047,700 |
| **Females.** | | | | | | |
| Ova very small.... | 41·1 | 142 | 31·7 | 57·6 | 0·30 | 8,700 |
| Ova very small.... | 41·5 | 340 | 37·5 | 58·1 | 0·79 | 27,500 |
| Ova fairly small.... | 46·5 | 340 | 32·3 | 39·3 | 1·17 | 23,700 |
| Ova fairly small.... | 47 | 454 | 39·2 | 46·5 | 0·45 | 13,125 |
| Ova small..... | 49·5 | 566 | 42·1 | 46 | 0·83 | 25,700 |
| Ova small..... | 54 | 679 | 72 | 50·6 | 1·35 | 79,000 |
| Ova small..... | 60·3 | — | 111·3 | 49·2 | 8·9 | 780,000 |
| Ova small..... | 63·5 | 1,020 | 122 | 53·6 | 1·1 | 115,000 |
| Ova small..... | 65·3 | 1,247 | 215 | 64 | 1·41 | 310,400 |
| Ova small..... | 67 | — | 129 | 40 | 8·84 | 730,000 |
| Developing ova.... | 70 | 1,133 | 92 | 57 | 7·47 | 627,000 |
| 2 embryos, 4 dev. ova..... | 70·7 | 2,067 | 138 | 29·6 | 14·32 | 936,000 |
| 4 embryos, 2 dev. ova..... | 74·5 | 2,492 | 170 | 37·6 | 8·7 | 890,000 |
| — | 83 | 2,267 | 153·7 | 62·9 | 20·11 | 3,100,000 |
| Live young in oviducts..... | 84 | — | 264 | 46·2 | 6·07 | 1,185,000 |
| Ovaries small..... | 85 | 2,380 | 336 | 74·9 | 3·82 | 1,539,000 |

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DEPARTMENT OF COMMERCE AND INDUSTRIES.

# FISHERIES AND MARINE BIOLOGICAL SURVEY DIVISION.

# INVESTIGATIONAL REPORT

No. 10.

## NOTES

on the

## VITAMIN A CONTENT OF THE LIVER OIL

of the

## VAALHAAI OR SOUPFIN SHARK

***(GALEORHINUS ZYOPTERUS).***

By

**J. A. M. ARCHER, M.Sc.**

Professional Officer.

# NOTES

# ON THE VITAMIN A CONTENT

# OF THE LIVER OIL

# OF THE VAALHAAI OR SOUPFIN SHARK

# (*GALEORHINUS ZYOPTERUS*).

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## Explanatory.

Data relative to the vitamin A content of the liver oil of the vaalhaai or soupfin shark (*Galeorhinus zyopterus*), covering a period of three and a half years (January, 1944–June, 1947), was collected.

These particulars were obtained from the records of a number of shark-liver-oil producers whose boats operate from a series of stations located along the Union coast-line from Table Bay (Cape Town) to Algoa Bay (Port Elizabeth). These are six such stations or centres from which vaalhaai livers are collected—for 1944 the figures for only four of these stations were available. The material derived from a specific station is not exclusively from the sea-area in its immediate vicinity, as craft from any one station operate to a greater or lesser extent in the sea-areas of other stations. While, therefore, the material cannot be identified in anything like an exclusive manner with a sharply demarcated sea-area of a particular station, it may be accepted that a very high percentage of the material is derived from the sea-area in the vicinity of a specific station, while the balance is more likely to be from the adjacent regions of the adjoining stations than from those further afield.

The livers derived from each station were processed separately and the oil and vitamin A content thereof determined From these particulars the annual average of oil and vitamin A content for each station for the above-mentioned period of three and a half years covered by the collected data was calculated.

The stations are numbered 1 to 6 in progressive order from Table Bay to Algoa Bay and represent the liver-collection centres of the following sea-areas :—

1. Dassen Island–Duiker Point.
2. Duiker Point–Cape Point.
3. False Bay.
4. Cape Hangklip–Cape Agulhas.
5. Cape Agulhas–Cape Infanta.
6. Algoa Bay.

All the results are tabulated hereunder and these form the bases of the graphs shown below as Figs. I to IV.

1944.

| Station. | $E\frac{1\%}{1\,cm.}$ ·328 mu. | Percentage Oil. | M.I.U./lb. Liver. | M.I.U./Shark. |
|---|---|---|---|---|
| 1 | 17·06 | 56·1 | 6·956 | — |
| 3 | 15·27 | 60·8 | 6·751 | 20·05 |
| 4 | 15·45 | 61·6 | 6·911 | 29·34 |
| 6 | 18·65 | 54·0 | 6·390 | — |

1945.

| | | | | |
|---|---|---|---|---|
| 1 | 10·95 | 56·8 | 4·516 | — |
| 2 | 19·32 | 53·6 | 7·526 | — |
| 3 | 13·00 | 65·9 | 6·220 | 22·67 |
| 4 | 15·15 | 60·0 | 6·600 | 23·35 |
| 5 | 14·68 | 69·3 | 7·391 | — |
| 6 | 17·84 | 48·1 | 6·233 | — |

1946.

| | | | | |
|---|---|---|---|---|
| 1 | 11·47 | 60·0 | 4·997 | — |
| 2 | 9·08 | 57·1 | 3·766 | — |
| 3 | 11·35 | 66·0 | 5·444 | 17·80 |
| 4 | 12·23 | 61·5 | 5·461 | 18·07 |
| 5 | 14·28 | 69·4 | 7·204 | — |
| 6 | 14·22 | 54·0 | 5·582 | — |

1947—(First Half).

| | | | | |
|---|---|---|---|---|
| 1 | 9·84 | 56·1 | 4·007 | — |
| 2 | 9·08 | 65·0 | 4·288 | — |
| 3 | 13·00 | 62·1 | 5·857 | 17·17 |
| 4 | 14·00 | 63·0 | 6·410 | 21·02 |
| 5 | 14·72 | 66·7 | 7·129 | — |
| 6 | 17·76 | 53·5 | 6·900 | — |

AVERAGES OVER $3\frac{1}{2}$ YEARS.

| Station. | $E\frac{1\%}{1\,cm.}$ ·328 mu. | Percentage Oil. | M.I.U./lb. Liver. | M.I.U./Shark. |
|---|---|---|---|---|
| 1 | 12·33 | 57·3 | 5·119 | — |
| 2 ($2\frac{1}{2}$ years) | 12·49 | 58·6 | 5·193 | — |
| 3 | 13·16 | 63·7 | 6·068 | 19·42 |
| 4 | 14·21 | 61·5 | 6·346 | 22·95 |
| 5 ($2\frac{1}{2}$ years) | 14·56 | 68·5 | 7·241 | — |
| 6 | 17·11 | 52·4 | 6·276 | — |

AVERAGE M.I.U./LB. OF TOTAL ANNUAL PRODUCTION.

| | |
|---|---|
| 1944 | 6·803 |
| 1945 | 6·291 |
| 1946 | 5·369 |
| 1947 (first half) | 5·630 |

## Conclusions.

1. The further eastwards a station is located the higher was the E-value of the liver oil produced at that station. In most instances the E-value was highest at the most easterly station (Fig. I). This phenomenon was true for every year from 1944 to June, 1947, except that during 1946 the E-value of the oil produced at the most easterly station, viz., No. 6, was slightly lower than that of No. 5, the station immediately west of it. The average E-value for the whole period for each station showed the progressive easterly increase very clearly.

2. From the tabulated figures and from Fig. I it is also seen that the average E-value of the oil derived from the same station varied considerably from year to year. This phenomenon may be ascribed to :—

### (a) Migratory Movements of the Vaalhaai.

During a specific year a greater number of larger-sized individuals may have been within the operational area of the fishermen from a particular station, or, for some reason or other, a majority of males may have been available. Investigations have revealed that males and females are not always present on

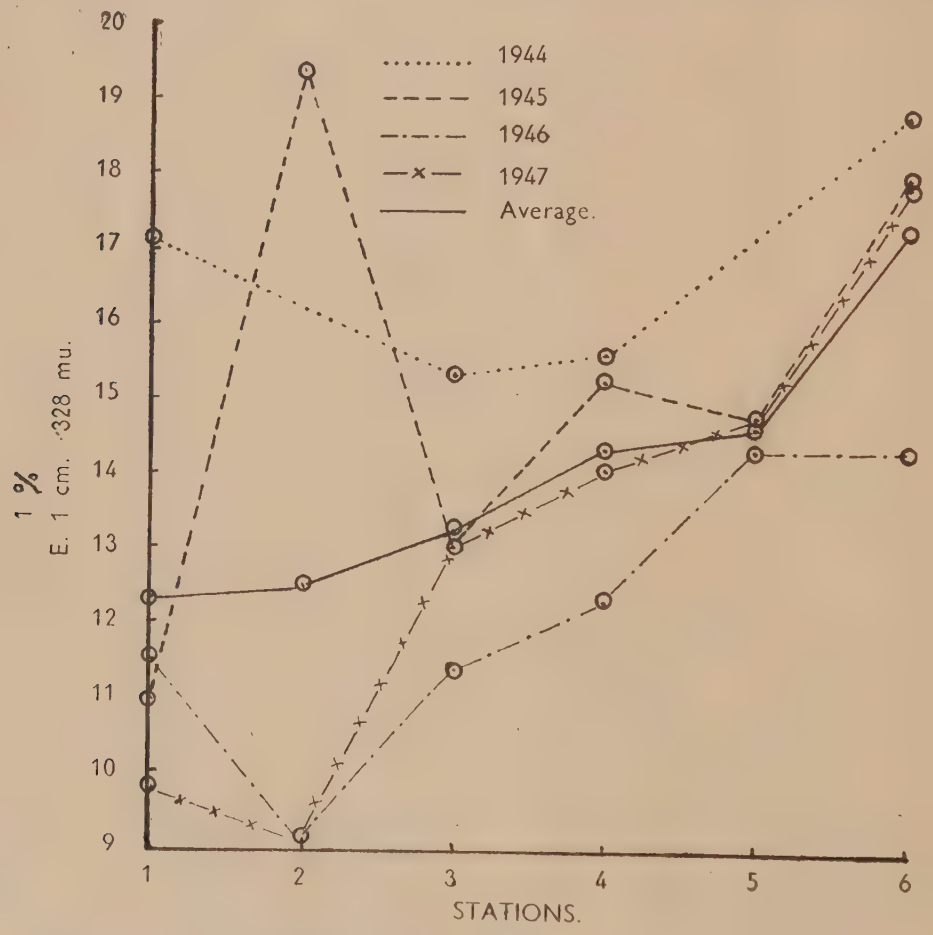


Fig. I.

The markedly high E-value of the liver oil produced at Station No. 2 during 1945 is ascribable to the fact that during this year a considerable quantity of snoek (*Thyrsites atun*) liver with a low percentage of oil but a very high E-value was mixed with the vaalhaai liver. In addition, it is noteworthy that during three years the oil produced at Station No. 1 consistently had a slightly higher E-value than that from Station No. 2.

the same grounds simultaneously, and from the researches of Dr. H. M Schwartz it is clear that the liver of a male vaalhaai has a higher vitamin A content (the $E\,\frac{1\%}{1\,cm.}$ ·328 mu. is also higher) than that of a female of equal size. Furthermore, vitamin A content increases with size. The average size and the proportionate male/female make-up of the annual catch can therefore influence the E-value of the liver oil produced in any one year.

### (b) The Sea-areas Fished.

If it is true that the E-value increases as we proceed eastwards, and during any one year more livers are derived from more easterly grounds, the E-value of the liver oil produced in that year can be higher than that produced in a year when a greater proportion of livers was derived from more westerly grounds. In this instance weather conditions along the coast will be a significant factor.

3. In the main for the period of three and a half years the vitamin A content per pound of liver (fourth column of the tables and Fig. II) also showed an increase in an easterly direction as far as Station No. 5, but liver derived from the most easterly station, viz., No. 6, had lower values, notwithstanding the fact that the E-value of the oil produced here was the highest. The tabulations clearly show that the percentage of oil recovered at Station No. 6 was considerably lower than that obtained at most of the other stations. The snoek livers mixed with the vaalhaai livers derived from Station No. 2 in 1945 were, as has already been noted above, responsible for the high value of the livers of that year.

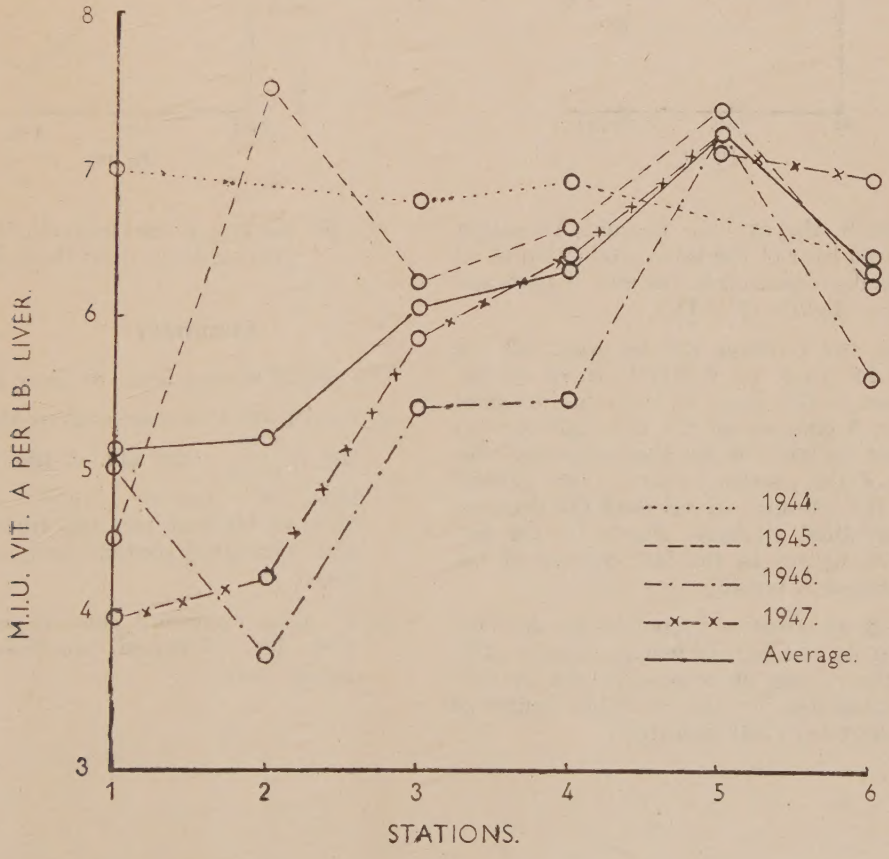


Fig. II.

4. The international units (millions) vitamin A per pound liver showed a decrease at each station from 1944 to 1946, followed by a small increase for the first half of 1947 (Fig. III), except in the cases of Stations Nos. 1 and 5.

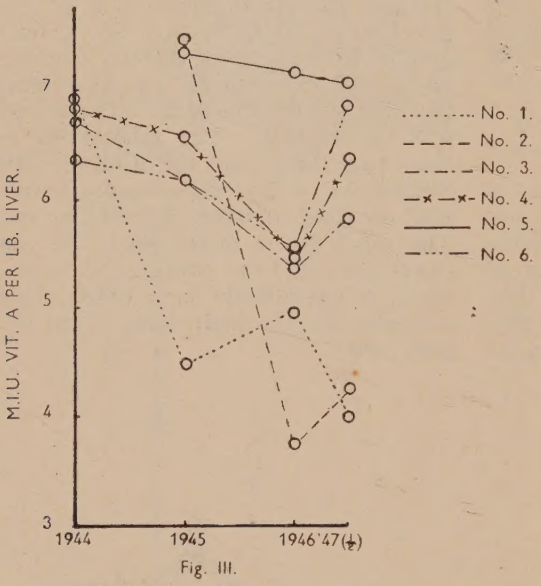

Fig. III.

Similarly the average vitamin A content per pound liver of the total production of all stations decreased up to the end of 1946 and then rose slightly (Fig IV).

What the position will be when all the figures for 1947 are available is, of course, unknown at this juncture, but the increased vitamin A content for the first half of 1947 does not compensate for the progressive decrease of the previous years. This general fall of the vitamin A level (and the decrease per individual vaalhaai shown by the few available figures in the last column of the tabulations) is possibly due to :—

(*a*) the progressive proportionate increase in the numbers of females caught—this theory can unfortunately not be substantiated by the available figures of the total vaalhaai catch ;

(*b*) the progressive decrease of the average size of vaalhaai caught because :—

(i) the larger-sized individuals are being caught out on the exploited known grounds ;

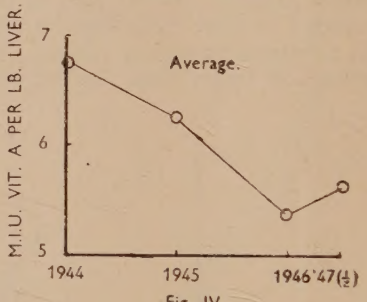

Fig. IV.

(ii) the larger-sized individuals are migrating away from these grounds.

## Summary.

The available data seem to show that :—

(*a*) from Table Bay eastwards to Algoa Bay the $E^{\frac{1\%}{1\ cm.}}$ ·328 mu. of the vaalhaai liver oil increases, and similarly also, as far east as Cape Infanta, the total vitamin A content per pound liver rises ;

(*b*) the total vitamin A content per pound liver has decreased progressiveiy in recent years.